REMARKS

Upon entry of the foregoing amendments, apparatus claims 1-3, 5-9, and 15-25 will be pending in the present application. Claims 4 and 10-14 have been cancelled without prejudice to pursuing those claims in one or more timely filed continuing applications.

Claims 1-3, 5-9 and 15-25 are pending in the present application and were rejected under 35 U.S.C. § 103(a) in the Office Action, made final, dated May 5, 2003, in parent application Serial No. 09/586,698.

Claims 1-3, 5, 16, 24 and 25 were rejected under 35 U.S.C § 103(a) as being obvious over Giallombardo et al. (WO 99/53557) in view of Kordesch et al. (Fuel Cells and Their Applications, VCH Publishers, Inc. 1996). Claims 6-9 and 17-21 were rejected as obvious over Giallombardo and Kordesch. Claim 15 was rejected as obvious over Giallombardo and Kordesch in view of Joshi et al. (U.S. Patent No. 5,681,435). Claims 1-3, 5, 16, and 22-25 were also rejected as being obvious over Ramunni et al. (European Patent Specification 872,906 B1) in view of Kordesch. Claims 6-9 and 17-21 were rejected as obvious over Ramunni in view of Kordesch. Claim 15 was rejected as obvious over Ramunni and Kordesch in view of Joshi.

Applicants maintain that the rejected claims are not obvious because there is no suggestion or motivation to modify or combine the cited references, and the cited references do not teach or suggest all the elements of the rejected claims. Furthermore, the prior art teaches away from the subject matter of the claims.

Applicants are submitting the Declaration of Stephen A. Campbell, one of the inventors of the present application, in support of the nonobviousness of the pending claims.

The Campbell Declaration provides evidence regarding nonobviousness and the state of the art before the December 16, 1999 filing date of U.S. Provisional Application No. 60/171,252. The present application claims the benefit of the filing date of the '252 application.

The Campbell Declaration states that it was not recognized that it was desirable for anodes having a supported catalyst in a fuel cell stack to be made more resistant to oxidative corrosion for purposes of tolerance to voltage reversal. (Cambpell Declaration, paragraph 3.) At that time, persons working in this field would not have used loadings of catalyst on the support in amounts greater than 40% by weight. They would have been discouraged from doing so by the following factors. (Cambpell Declaration, paragraph 4.)

First, it was recognized that anodes having increased loading above a certain level had decreased specific catalyst activity. (Cambpell Declaration, paragraph 5.) Although the surface of the support would be covered with more catalyst if the loading was increased, the specific activity of the catalyst would not be as high (as measured as activity/gram) as it would be at lower loadings. (Id.) In a comparison of platinum loading of an electrode to the specific catalyst activity of the electrode, the specific catalyst activity increased with increasing platinum loading up to 20%. (Id.) The specific catalyst activity then decreased as the platinum loading is increased above 20%. (Id.) That is, the optimal platinum loading for specific catalyst activity occurs at around 20% Platinum loading. (Id.)

At the time before December 16, 1999, it was known that the effective metal catalyst surface area decreased with increasing loading, thereby resulting in a decrease in specific catalyst activity. (Cambpell Declaration, paragraph 6.) Accordingly, anodes with catalyst loadings above 40% by weight would have been recognized at that time as having lower specific catalyst activity than smaller loadings. (Id.) This would have discouraged the use of catalyst loadings greater than 40% by weight. (Id.) The references cited by the Examiner support this

statement, in that they teach away from the use of catalyst loadings greater than 40%. (Id.) For example, in Giallombardo International Publication No. WO 99/53557, the examples employ a catalyst loaded on a carbon support at approximately 30% by weight. (Id.) As another example, Ramunni European Patent No. 872,906, paragraph 0023, recites an optimum catalyst loading of 30-40%. (Id.)

Second, persons working in this field at that time would have wanted to minimize the amount of catalyst on each anode in order to minimize costs. (Cambpell Declaration, paragraph 7.) With decreased specific catalyst activity comes increased cost, especially when the catalyst is a precious metal such as platinum. (Id.) Therefore, decreased specific catalyst activity results in increased fuel cell costs. (Id.) This also would have discouraged the use of catalyst loadings greater than 40% by weight. (Id.)

Prior to December 16, 1999, there were not any known benefits to loading an anode catalyst above 40% by weight in a fuel cell stack that would have outweighed the known drawbacks (as described above) which discouraged doing so. (Campbell Declaration, paragraphs 8 and 9).

Giallombardo and Ramunni and other prior art references teach away from the present claims. Giallombardo and Ramunni teach away from the subject matter of the rejected claims. Giallombardo's examples employ a catalyst loaded on a carbon support at approximately 30% by weight. Ramunni shows there is no benefit in cell voltage from higher noble metal loadings in the catalytic layer. (See Ramunni, at Table 2).

Giallombardo shows that loadings between 20-40% or 10-40% are preferred (see, for example, page 8, line 12 and page 11, lines 14-15). The only loading on the carbon support actually employed throughout all Giallombardo's examples is 30%. Furthermore, Giallombardo discourages the use of highly loaded anode catalysts by indicating that the effective platinum surface area drastically decreases for loadings above 40%. (Page 9, Table 1). This is clearly a disadvantage, since Giallombardo is directed to high-surface area formulations of supported catalysts. (See Giallombardo, page 8, lines 8-9).

Similarly, Ramunni does not disclose an advantage for using higher anode catalyst loadings. The Office Action asserts that samples M, N, W, and X have loadings of noble metal in the catalytic layer greater than 40%. (Office Action, page 4). The Office Action's reliance on these examples was misplaced. First, samples M and N are not disclosed as anodes; they are only

employed as cathodes. Samples M and N are shown in Table 2 as being used in Tests Nos. 23 and 24, and in those tests, they are only used as cathodes. Next, although samples W and X are used as anodes in Test Nos. 26 and 27, their performance is inferior or the same as samples Q and V, which have lower catalyst loadings. (See Test Nos. 20 and 25, which test Q and V against cathode U). Thus, Ramunni teaches that lower catalyst loadings should be used. One of ordinary skill in the art would not use higher anode catalyst loadings after reviewing Ramunni. Finally, Ramunni clearly prefers catalyst loadings outside the range of the rejected claims: "[T]he optimum noble metal dispersion on carbon, both in the case of pure platinum or alloy thereof, is comprised in the range of <u>30-40% by weight</u>." (Ramunni, paragraph 0023).

In contrast, Applicants' rejected claims require supported catalysts with anode catalyst loadings greater than 40% in solid polymer electrolyte fuel cell stacks for voltage reversal purposes. The prior art does not teach this. In fact, the prior art consistently teaches away from using such high loadings of catalyst. As discussed above, Giallombardo prefers catalyst loadings in the range of 10% to 40%, while other prior art of record concurs with this preference. In *"Simulation Studies on the Fuel Electrode of a H_2-O_2 Polymer Electrolyte Fuel Cell,"* Electrochimica Acta, Vol. 37 No. 15, pp. 2737-2745, the authors

stated "The effect of the platinum coverage on the total current density is shown in Fig. 8. With increasing coverage, the total current density increases rapidly at first, <u>then only slowly at coverages larger than about 20%</u>." *Id.* at page 2742, column 1 (emphasis added). Thus, one of ordinary skill in the art would be discouraged from using higher loadings of catalyst.

Claims 6-9 and 17-21 were rejected as obvious over Giallombardo and Kordesch, as well as Ramunni and Kordesch. The Office Action conceded that the cited references do not discuss the surface coverage of the catalyst on the carbon support, the catalyst/support interface perimeter, or the relative oxidation resistance of the carbon support. However, the Office Action repeated its conclusion from the earlier Office Action, that these characteristics were inherent. Applicants submit that the Office Action has not satisfied its burden in proving inherency, since it has no evidence of the inherency of this catalyst/support interface perimeter. Applicants submit that higher loading and Pt particle size do not necessarily translate into decreased catalyst/support interface perimeter.

Claim 15 was rejected as obvious over Giallombardo and Kordesch, and further in view of Joshi, as well as over Ramunni and Kordesch, and further in view of Joshi. The Office Action asserted that Joshi teaches the inclusion of Ebonex (a conductive

Ti_4O_7 material) in the anode structure of a precious metal oxide and graphite support, because it prevents the decay in performance of the anode. From this, the Office Action concluded that it would have been obvious to one of ordinary skill in the art to add Ti_4O_7 material in the anode structure of a fuel cell stack.

This conclusion was erroneous because Joshi does not disclose or suggest a <u>fuel cell</u> anode or its materials. Indeed, Joshi does not relate to a galvanic cell (one which provides electricity) but rather to an electrolytic cell (one which consumes electricity). The anodes in electrolytic cells perform a very different job than the anodes in galvanic cells, and one of ordinary skill in the art would not assume that anodes for electrolytic cells could be substituted as anodes for galvanic cells.

Joshi discloses an electrochemical pump for pumping oxygen, and its electrodes evolve acidic oxygen in such a pump. There is no reason to believe that one of ordinary skill in the art would have adopted such electrodes for use in a fuel call. To the contrary, Joshi itself discourages such adoption. Joshi points out that the platinum-on-carbon constructions of Wilson and Gottesfeld are <u>not suitable</u> for Joshi's application. Joshi then suggests use of Ti_4O_7, but not for fuel cells. One of ordinary

skill would <u>not</u> have assumed that Joshi's electrodes were suitable for fuel cells.

For the foregoing reasons, Applicants submit that claims 1-3, 5-9, and 15-25 are patentable and not obvious.

In this preliminary amendment, Applicants have deleted the term "about" in claims 1 and 16 to provide greater clarity to those claims. Applicants submit, however, that the deletion of the term "about" in the recitation of catalyst quantity should not, and does not, preclude applicants from asserting that the claims encompass catalyst quantities slightly less than the specified amounts that nevertheless achieve voltage reversal tolerance by equivalent means.

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In view of the foregoing amendments and remarks, applicants submit that claims 1-3, 5-9 and 15-25 are in condition for allowance. The Examiner is invited to telephone the applicants' undersigned attorney at (312) 775-8202 if any unresolved matters remain.

Please charge any fees incurred in connection with this submission to Deposit Account No. 13-0017.

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